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ABSTRACT

Knowledge-based expert computer systems are addressing issues relevant to all special educators, but are particularly relevant in rural settings where human experts are less available because of distance and cost. An expert system is an application of artificial intelligence (AI) that typically engages the user in a dialogue resembling the conversation a person might have with an expert consultant. The expert systems could serve as consultants to the educator in addressing issues such as identification, diagnosis, and remediation of problems presented by special education students. A number of computer systems are available or under development that may be of immediate value to rural educators. One such system is the Buggy program which identifies a student's arithmetic misconceptions by analyzing error patterns from test problems worked by the student. Several prototype programs are being developed by the staff of the Special Education AI Project at Utah State University to test the feasibility of using expert systems to solve problems in special education. For example, two CLAS.LD systems provide second opinions regarding the accuracy of the "learning disabled" classification. To prepare themselves to capitalize on the advantages of new technologies such as expert systems, educators in rural settings can develop their technological literacy. (JHZ)

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The Potential of Computer-Based Expert Systems for Special Educators in Rural Settings

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Running Head: EXPERT SYSTEMS

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Abstract

This article presents computer-based expert and knowledge systems as a potential tool for educators in rural settings. The expert systems could serve as consultants to the educator in addressing issues such as identification, diagnosis, and remediation of problems presented by special education students. Prototype systems are described and rural educators' applications of these systems are suggested.

The Potential of Computer-Based Expert Systems for Special Educators in Rural Settings

Teachers in small schools face many of the same instructional and motivational problems as teachers in schools with larger populations. Unfortunately, teachers in rural areas often have had relatively little support in facing those problems. In larger school districts, for example, teachers can draw on the knowledge and experience of colleagues who teach children in the same grade or within similar content areas. In addition, larger districts often employ a staff of psychologists, behavior consultants, curricular coordinators, special education directors, and others whose jobs involve assisting teachers. Teachers in small schools often lack this support.

Reasons frequently cited to explain the lack of support services in rural districts are (too much) geography and (lack of) money (Helge, 1984; Kirmer, Lockwood, Mickler, & Sweeney, 1984). Many rural schools lack a tax base which will support an extensive number of relatively expensive adjunctive personnel. Further, the large physical size of many districts makes providing itinerant consultant services difficult and often impractical.

What is needed is a group of educational experts who are readily available to teachers and administrators at

each school of a rural district. These experts should have the knowledge and experience to provide quality consultative services. Finally, these experts should provide services at a cost that is affordable to school districts with limited financial resources.

Characteristics of knowledge-based expert computer systems fit well with rural school district needs for educational experts. That is, the knowledge-based expert systems can provide teachers and administrators with readily available advice about a specific content area. Also, a knowledge-based expert system has the potential to capture practical experimental knowledge for dissemination to teachers and administrators (Weiss & Kulikowski, 1984). Additionally, expert systems have the potential to provide educators in a rural setting with advice at a reasonable cost.

A knowledge-based expert system is an application of artificial intelligence (AI). That is, it is a computer-based system designed to emulate the knowledge of a human expert for solving problems. An expert system typically engages the user in a dialogue. This dialogue, in many ways, parallels the conversation a person might have with an expert consultant. The system presents questions that will pinpoint the problem and gathers information from the user. Then the program combines the facts supplied by the user and rule-based logic of the computer program to generate

solutions to the problem (Stefik, Aikins, Balzer, Benoit, Birnbaum, Hayes-Roth, Sacerdoti, 1983).

Expert System Examples

Expert systems have effectively solved problems in a number of areas. PROSPECTOR, for example is an AI program which is used in the field of mineral exploration. PROSPECTOR interprets soil and geological data and predicts the probable location of mineral deposits. In an experiment testing PROSPECTOR's effectiveness, users correctly predicted the location of a molydbenum deposit worth one-hundred million dollars (Feigenbaum & McCorduck, 1983).

Another program, MACSYMA was designed to solve a variety of complicated mathematical problems (Sleeman & Brown, 1982). Scientists and engineers access MACSYMA through a telephone network. Research chemists employ DENDRAL. Using mass spectral and nuclear magnetic resonance information, DENDRAL can identify a substance's potential molecular structure (Feigenbaum & McCorduck, 1983).

MYCIN, a well-known expert system used in the medical field, has led to educational applications (Davis, Buchanan, and Shortliffe, 1975). This program allows the user to feed in information about the characteristics of bacterial cultures along with the patient's present symptoms. Combining the patient's data with the rule-based logic of the computer program, the bacterial disease is identified. In its initial form, this intelligent data base was used as

was used as a diagnostic tool by the physician. This same intelligent data base was then included in an intelligent CAI program, NEOMYCIN (Clancy & Letsinger, 1981), designed to be used to teach the diagnosis of bacterial disease.

Potential Application In Rural Education

Hayes-Roth, Waterman, and Lenat (1983) suggest that expert systems may be developed in the areas of prediction, interpretation, diagnosis, remediation, planning, monitoring, and instruction. It is clear that there may be teachers in rural schools who might find such computer-based expert systems to be useful.

A number of systems are being (and have been) developed which may be of immediate value to rural educators. One such system would be the BUGGY model which led to the DEBUGGY diagnostic system used by teachers to diagnose arithmetic errors (Sleeman & Brown, 1982). The BUGGY program considers all possible student solution paths (both correct and incorrect) in solving arithmetic problems. Recognizing that nearly 80 percent of all student errors are systematic in nature, the BUGGY system identifies the student's misconceptions by collecting evidence of error patterns from test problems worked by the student (Roberts & Park, 1983). Instruction can be planned to specifically address the student's errors, that is, "bugs".

An extension of the BUGGY system, the DEBUGGY diagnostic system, has been used with several thousand

students to identify systematic errors made by students in solving math problems (Sleeman & Brown, 1982). The authors of DEBUGGY approached diagnosis as a more informative process than simply determining if a student has mastered a skill. Thus, by combining the rule-based logic of DEBUGGY and student data, the computer outputs the subskills the student still needs to master and the rules the student has internalized resulting in the incorrect answer. Diagnosis at this level is useful for the teacher in planning specific remediation to address the student's need. Such a diagnostic resource is especially advantageous for a teacher isolated in a rural setting with few, if any, available diagnosticians to assist the teacher.

In the area of learning disabilities, Colbourn & McLeod (1983) have developed a computer-guided diagnosis of reading difficulties prototype that could be used by the educator in a rural setting. The system does not necessarily test the student directly but utilizes the assessment information gathered by the teacher. Colbourn and McLeod (1983) describe their expert system:

> The present expert system guides the user through the various stages and levels of diagnosis, from the initial suspicion that a reading problem may exist through to the point at which sufficient information has been gathered to plan an appropriate remedial program. Assessment begins

> with the gathering of relevant data concerning the child's physical, mental, emotional, social and academic developmental history. In addition to the assessment of the child's general skills in academic areas such as reading, spelling and arithmetic, the expert system examines psycho-educational correlates that include those intellectual, visual, auditory and language skills deficiencies which might be related to learning disabilities. As the assessment of the child's learning difficulties progresses, academic skills are subjected to finer and finer scrutiny until the nature of the child's problems has been pinpointed exactly. (p. 32)

With the specific nature of the child's problems identified, teachers can turn their attention to development and implementation of a successful instructional plan. Hopefully, services for the student began sooner since delays in the diagnostic process have been reduced, if not eliminated.

Other expert systems addressing the area of learning disabilities have been developed by Hofmeister (1984) and Ferrara (1984). These systems, CLAS.LD EE and CLAS.LD ML, respectively, provide second opinions regarding the accuracy of the classification "learning disabled". In response to a series of questions posed by the computer program, the user

inputs the psychological and educational information gathered by the child's assessment team. Then the assessment information and rule-based logic are combined to output a judgement about the appropriateness of a learning disability classification for the student.

The systems operate on high-powered microcomputers and are under study for their value as consultants as well as clinical training resources whereby graduate students can test their classification skills against the expert systems. The computer programs encompass the Utah state rules and federal regulations related to Public Law 94-142 in their problem solving processes. The expert knowledge was built on the opinions of recognized authorities in learning disabilities.

The CLASS.LD systems are two of several prototype programs being developed or planned by staff of the Special Education AI Project at Utah State University to test the feasibility of using expert systems to solve problems in special education. The other prototype programs address such issues as: (a) using test information to diagnose specific skill deficits in children, (b) evaluating the efficacy of instruction based on student performance data, (c) evaluating administrative program decisions, and (d) considering classroom management problems and suggesting solutions. The issues addressed in these programs are relevant to all special educators, but particularly relevant

to special educators in rural settings where human experts are less available because of distance and cost.

Many of the expert systems discussed above are in the prototype stage of development. It will be several months before they are completely field-tested, and months after that before they are available to teachers in public schools. Nonetheless, rural education should be alert to the potential these systems offer. Educators in rural settings can prepare themselves to capitalize on the advantages of new technologies such as expert systems by developing their technological literacy (Hofmeister, 1984).

Summary

During a presentation to Congress, Bell (1983) made the observation that "Too much computer software is simply electronic page turning, and it has little advantage over a well-illustrated book" (p. 4). The knowledge-based expert system application of Artificial Intelligence represents a dramatic shift from "electric page turning".

We believe that expert systems can and should play an important role in the future of rural education.

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